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VARIATIONS IN AGRONOMIC TRAITS OF SOYBEAN GENOTYPES

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ABSTRACT

The experiment was conducted at the experimental site of Agronomy Department of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur during January to June 2010 to evaluate some important agronomic traits of one hundred and fifteen genotypes of soybean to screen out high yielding soybean genotypes. Considerable genetic variability was observed in the 115 germplasm. Depending on the variability in quantitative traits, the genotypes were grouped in six clusters. The genotypes which have greater morphological similarity were grouped in clusters. The results indicated the presence of high degree of divergence in the genotypes. The clustering pattern of the 115 soybean genotypes in six groups and their inter-group distances revealed that genotypes in Cluster III comprised of BARI Soybean 5, G00083, BARI Soybean 6, G00342, BD 2338, BD 2355, BD 2329, BD 2340, AGS 95, G00056, AGS 129, BD 2336, BGH 02026, BGM 02093, Galarsum, BD 2350, G00084, BD 2331, G00103 indicated better performance which could be marked for the selection of yield potential genotypes through further evaluation.

INTRODUCTION

Soybean (*Glycine max* L.) is one of the most nutritious crops (Yaklich et al., 2002). Its seed contains 42-45% protein and 22% edible oil (Mondal et al., 2002). Recently soybean has become an important crop in Bangladesh as its demand is increasing significantly. It is mostly used as poultry and fish feed in

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our country. Currently, a huge quantity of soybean has been imported to meet the demand in the market.

Bangladesh is a densely populated country. It is facing tremendous pressure of food demand to feed the increasing number of population. The area of cultivable land is also decreasing. The total area of cultivable land reduced alarmingly from 20 million ha in 1983-84 to 14.8 million ha in 2008 (Khan et al., 2008). Therefore essential crops are in competition for getting lands for cultivation. Thus, farmers of Bangladesh grow cereal crops for their food security in the good soils and non-cereals are mostly grown on the marginal lands.

Soybean is one of the non competitive crops for the farmers of Bangladesh and could fit on the marginal lands especially in the char and coastal lands. In Bangladesh thirty percent of the net cultivable areas are in the coast. Of the 2.85 million hectares of the coastal and off-shore areas, about 0.83 million hectares of the arable lands are affected by varying degrees of soil salinity (Karim et al., 1990). Hence, most of the cultivable land remains fallow during winter season due to salinity in southern region of Bangladesh. Increasing the cropping intensity is an important task ahead to improve the agricultural productivity of the coastal saline lands. Exploiting the relatively low saline areas after rainy season rice harvest by growing saline tolerant crops can be a profitable and sustainable option for the farmers. Soybean classified as moderately salt sensitive crop (Katerji et al., 2003). It may be grown in low saline areas. On the other hand, charland areas are estimated to be 0.82 million hectares in Bangladesh, out of which about 64 to 97% area is cultivable (Ahmed et al., 1987). Cultivated soils of chars are mostly loam to silty loam with slightly acidic to slightly alkaline in reaction and deficient in plant nutrients as well as organic matter contents (SRDI, 2002). Islam and Rahman (2011) also reported good performance of soybean in charland.

Being a member of legume family, soybean fetches profitable returns to the growers even with minimum agricultural inputs. However, the ultimate yield of a crop depends upon the interaction between its genetic makeup and environmental factors faced during its entire growing period (Humphreys, 1989; Ashraf, 1994). Therefore, it is needed to find out high yielding soybean genotypes suitable for char lands and also saline belt to utilize fallow lands. A large size of germplasm of a crop might have some considerable genetic variability. The experiment was therefore planned to select soybean genotypes with high yield potential.

MATERIALS AND METHODS

The experiment was conducted at the research field of the Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur, Bangladesh during January to June, 2010. The soil was silty clay in texture with pH of 6.5. The experiment was laid out in a RCB design with three replications. The study comprised of 115 genotypes of soybean including two released varieties viz., BARI Soybean 5 and BARI Soybean 6 as check. The genotypes were collected from BARI and AVRDC.

Seeds were sown in January 16, 2010 and harvested from April 22 to June 20, 2010 due to differences in life span of the genotypes. The seeds of soybean genotypes were sown in lines of one meter length maintaining 10 cm distances. Row to row spacing was 40 cm, maintaining 10 plants per meter. Fertilizers were applied at the rate of 28-30-60-18 kg ha^{-1} of NPKS in the form of urea, TSP, MOP and Gypsum, respectively (FRG, 2005). Half of urea and full doses of other fertilizers were applied at the time of final land preparation. The remaining half of urea was top dressed at flowering stage followed by irrigation. After sowing one-irrigation was applied for uniform emergence and thereafter three additional irrigations were given to the plots for meeting the water at different critical stages of soybean. Soybean plants emerged on January 24. Admire 200SL @ 1 ml $liter^{-1}$ of water was sprayed at 10 and 25 DAE to control Jassids and white flies. Ripcord 10 EC @ 1 ml $liter^{-1}$ of water was sprayed at 45 and 60 DAE to control leaf roller and pod borer. Leaf SPAD values, leaf width and breadth were recorded at 45 DAE and plant height was measured at 75 DAE. After harvest, yield and yield contributing characters were recorded.

Average values of morphological and yield contributing characters viz., seed yield linear $meter^{-1}$, seed yield $plant^{-1}$, 100-seed weight, number of pods $plant^{-1}$, number of seeds pod^{-1}, number of branches $plant^{-1}$, plant height, leaf SPAD value, leaf length, leaf width and days to maturity were analysed for multivariate analysis by using GENESTAT program.

RESULTS AND DISCUSSION

Maximum, minimum and mean values of eleven quantitative traits of the 115 soybean genotypes are presented in table 1. The seed yield per linear meter ranged from 11.80 to 97.76 g. The seed yield per plant ranged from 1.29 to 9.66 g. 100-seed weight ranged from 5.48 to 24.93 g. The number of pods $plant^{-1}$ ranged from 14.33 to 57.78. Number of seeds pod^{-1} ranged from 1.6 to 2.5. Number of branches $plant^{-1}$ ranged from 1 to 6. Plant height ranged from

8.78 to 93.44 cm. Leaf SPAD values ranged from 28.10 to 45.70. Leaf blade length ranged from 5.2 to 10.9 cm. Leaf blade width ranged from 3.3 to 7.6 cm and crop duration ranged from 80 to 149 days. These results of quantitative traits indicated that there were wide variations in 115 soybean genotypes. Variability in quantitative traits could provide a guide line for the selection of best lines of soybean in cropping system improvement. Variations in plant characters of soybean genotypes also were reported by Iqbal et al. (2008).

The grouping of different soybean genotypes in clusters for quantitative traits is presented in table 2. Cluster I comprised of 14 genotypes, which represented 12.17% of the total genotypes. The Cluster II represented 4.35% with 5 genotypes. The Cluster III and Cluster IV, both were accounted for 16.52% of the total, which comprised of 19 genotypes in each. The Cluster V and Cluster VI contributed 25.22% of all and comprised of 29 genotypes in each group. The results indicated the presence of high degree of divergence in the genotypes.

The cluster mean values and standard deviations for different plant characters in groups are presented in table 3. The clusters differed in mean values for almost all the characters. It was observed that maximum seed yield linear meter^{-1} (71.59 g), maximum seed yield plant^{-1} (7.20 g), maximum 100-seed weight (10.06 g), more number of filled pods plant^{-1} (38.71), more number of seeds pod^{-1} were recorded in Cluster III, which was followed by Cluster IV with all contributing traits. However, the least seed yield linear meter^{-1} (14.20 g) and seed yield plant^{-1} (1.59 g), least number of pods plant^{-1} (19.02) and seeds pod^{-1} (1.82) were obtained from Cluster II. The genotypes in Cluster I showed early maturity (83 days) and in Cluster II showed late maturity (143 days). The genotypes which have greater morphological similarity were grouped in clusters. Ghatge and Kadu (1993) reported seven clusters derived from 58 soybean genotypes. Several researchers studied with genetic diversity of soybean and grouped them in clusters (Mehetre et al., 1994; Kumar and Nadarayan, 1994; Iqbal et al., 2008).

It was found in principal component analysis that three components had greater than one eigen values which contributed 71.11% of the total variation among 115 genotypes of soybean (Table 4). It was observed that principal component 1 with eigen value of 3.915 contributed 35.59%, principal component 2 with eigen value of 2.187 contributed 19.89% and principal component 3 with eigen value of 1.720 contributed 15.63% of the total variation.

The traits which were potentially important could be exploited through principal component analysis (Table 5). The genetic variance to principal component 1 and principal component 2 were contributed commonly by 100-seed weight, leaf SPAD value and leaf width. The traits, which contributed positively to 1st principal components, were seed yield plant^{-1} (0.1009), 100-seed weight (0.0233), number of pods plant^{-1} (0.0032), number of seeds pod^{-1} (0.9369), SPAD value (0.0333) and leaf width (0.4834) showed positive eigen vector values while the others had negative values. The positive genetic variance to 2nd principal components were contributed by 100-seed weight (0.0022), number of branched plant^{-1} (0.0772), SPAD value (0.0481), leaf length (0.2542), leaf width (0.0422) and days to maturity (0.0788). The rest of the characters had negative eigen vector values. Iqbal et al. (2008) reported that quantitative traits that contributed positively in principal component analysis could be given considerable importance for the genetic material under investigation.

Graphical illustration of the six cluster groups of soybean according to the first and 2nd discriminators functions is presented in figure 1. Discriminatory analysis revealed that Cluster II and Cluster III only showed complete separation from others. There were mixed up of Clusters in between IV and V, and in Clusters I and VI.

Inter-group distances (D^2) between six clusters of soybean genotypes are presented in table 6. The distances calculated by discriminatory function analysis (DFA) showed maximum distance (12.405) between Cluster I and Cluster II which was followed by the distance (10.531) between Cluster II and Cluster III. But Cluster III and Cluster IV were in closer distance (1.929) as compared to distance from Cluster V (3.553) and Cluster VI (4.924). The closer distance between the cluster groups indicated genetically closeness. The cluster mean values for different yield contributing characters which have considerable importance in clustering of 115 soybean genotypes in six groups and their inter-group distances revealed that genotypes in Cluster III showed better performance which could be marked for the selection of yield potential genotypes. Several researchers also showed this system to characterize and select genotypes of different crops (Ghafoor et al., 2001; Elizabeth et al., 2001; Rabbani et al., 1998; Islam et al., 2007; Amiruzzaman et al., 2013).

CONCLUSION

Considerable genetic variability was identified in the 115 soybean genotypes. The genotypes were grouped in six clusters on the basis of their variability in quantitative traits. The results concluded that the Cluster III comprised of BARI Soybean 5, G00083, BARI Soybean 6, G00342, BD 2338, BD 2355, BD 2329, BD 2340, AGS 95, G00056, AGS 129, BD 2336, BGH 02026, BGM 02093, Galarsum, BD 2350, G00084, BD 2331, G00103 genotypes performed better than others, because of its better quantitative traits and higher inter-group distances.

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Table 1: Maximum, minimum and mean values of eleven quantitative traits of 115 soybean genotypes

Traits	Maximum	Minimum	Mean
Seed yield linear meter^{-1} (g)	97.76	11.80	46.04
Seed plant^{-1} (g)	9.66	1.29	4.87
100-seed weight (g)	24.93	5.48	11.49
No. of pods plant^{-1}	57.78	14.33	28.87
No. of seeds pod^{-1}	2.50	1.60	2.19
No. of branches plant^{-1}	6.10	1.00	3.72
Plant height (cm)	93.44	8.78	47.03
Leaf SPAD value	45.70	28.10	35.90
Leaf length (cm)	10.90	5.20	8.36
Leaf width (cm)	7.60	3.30	5.48
Days to maturity	149	80	100.5

Table 2: Grouping of soybean genotypes based on six clusters for various traits

Cluster	F	% Age	Cluster membership
Cluster I	14	12.17	G00138, G00343, G00046, G00042, G00207, G00197, G00166, G00351, G00196, G00221, G00041, G00204, G00154, G00053
Cluster II	5	4.35	G00098, G00069, G00091, G00117, G00096
Cluster III	19	16.52	BARI Soybean 5, G00083, BARI Soybean 6, G00342, BD 2338, BD 2355, BD 2329, BD 2340, AGS 95, G00056, AGS 129, BD 2336, BGH 02026, BGM 02093, Galarsum, BD 2350, G00084, BD 2331, G00103
Cluster IV	19	16.52	Shohag, BD 2342, Bangladesh soybean 4, PK 416, BD 2337, BD 2335, G00003, G00015, MTD 453, BD 2327, G00382, G00006, G00032, G00035, BD 2339, ASET 95, G00389, AGS 275, MTD 459

Cluster V	29	25.22	G00336, BD 2326, BD 2349, G00020. BD 2354, G00124, G00060, G00063, G00002, G00108, BD 2353, MTD 10, G00111, G00095, G00019, G00017, G00076, G00105, G00068, G00005, BD 2347, BGM01001, G00073, G00387, BD 2346, ST 2, ASET 93, G00011, PK 327
Cluster VI	29	25.22	AGS 399, G00209, G00061, AGS 313, G00390, G00045, G00329, G00238, G00247, G00078, AGS 400, G00034, G00059, G00312, G00027, G00348, AGS 405, G00256, G00288, G00374, BD 2330, G00193, BD 2332, G00324, G00362, G00331, G00206, AGS 403, G00184

F- Frequency, % Age - percentage

Table 3: Mean values and standard deviation for six clusters based on eleven quantitative traits of 115 soybean genotypes

Traits	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Cluster VI
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Seed yield linear m^{-1} (g)	34.34±8.43	14.20±2.66	71.59±10.29	49.68±6.55	46.01±8.85	38.08±8.92
Seed yield $plant^{-1}$ (g)	3.75±0.68	1.59±0.27	7.20±1.04	5.03±0.57	4.84±0.77	4.36±1.03
100-seed weight (g)	12.07±1.77	12.54±1.80	10.06±2.66	9.74±2.44	11.17±2.09	13.45±4.30
No. of pods $plant^{-1}$	20.78±2.41	19.02±3.72	38.71±8.02	34.09±8.09	30.20±6.16	23.29±4.75
No. of seeds pod^{-1}	2.15±0.15	1.82±0.16	2.22±0.09	2.23±0.13	2.26±0.09	2.19±0.17
No. of branches $plant^{-1}$	2.20±0.09	4.24±1.00	4.61±0.79	4.11±0.78	4.22±0.67	3.02±0.67
Plant height (cm)	15.07±4.47	75.13±11.67	53.38±6.82	55.29±8.50	55.64±7.04	39.44±6.85
Leaf SPAD value	38.65±3.77	35.36±2.18	35.12±2.36	35.35±2.25	34.73±3.07	36.70±3.41
Leaf length (cm)	7.19±0.78	8.30±0.19	8.53±0.52	8.63±0.70	8.78±0.72	8.22±1.06
Leaf width (cm)	4.71±0.50	5.54±0.24	5.53±0.45	5.57±0.50	5.72±0.47	5.51±0.79
Days to maturity	83.29±7.69	143.00±12.0	103.16±7.17	93.74±3.24	110.59±4.89	94.24±7.05

Table 4: Principal components and extracted eigen values in principal components analysis (PCA)

PCA	Latent root/ Eigen value	Variation (%)	Cumulative variation (%)
1	3.915	35.59	35.59
2	2.187	19.89	55.48
3	1.720	15.63	71.11
4	0.852	7.75	78.86
5	0.749	6.81	85.67
6	0.547	4.97	90.64
7	0.405	3.68	94.32
8	0.224	2.04	96.36
9	0.200	1.82	98.18
10	0.156	1.42	99.60
11	0.045	0.40	100.00

Table 5: Extracted Eigen values and latent vectors associated with two principal components

Plant characters	Latent vectors	
	Vector-1	Vector-2
Seed yield linear m^{-1} (g)	-0.0208	-0.0483
Seed yield $plant^{-1}$ (g)	0.1009	-0.5684
100-seed weight (g)	0.0233	0.0022
No. of pods $plant^{-1}$	0.0032	-0.0541
No. of seeds pod^{-1}	0.9369	-0.6674
No. of branches $plant^{-1}$	-0.4122	0.0772
Plant height (cm)	-0.0947	-0.0332
Leaf SPAD value	0.0333	0.0481
Leaf length (cm)	-0.5985	0.2542
Leaf width (cm)	0.4834	0.0422
Days to maturity	-0.0686	0.0788

Table 6: Inter-group distances (D^2) between six clusters of soybean genotypes

Clusters	1	2	3	4	5	6
1	-	12.405	7.984	6.439	7.180	3.652
2	-	-	10.531	9.422	7.260	9.522
3	-	-	-	1.929	3.553	4.924
4	-	-	-	-	2.162	3.089
5	-	-	-	-	-	3.530
6	-	-	-	-	-	-

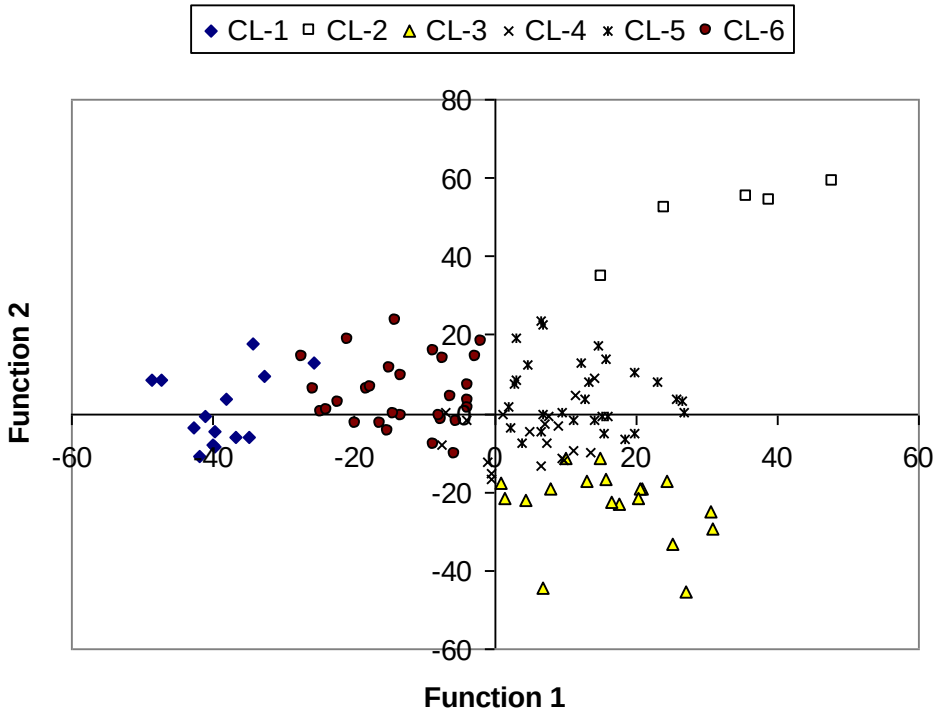

Figure 1: Scatter diagram on cluster diversity for two PCs of 115 soybean genotypes